

## **Annex 1: Terms of Reference**

### **Review of the Atlantis Ecosystem Model in Support of Ecosystem-Based Fishery Management in the California Current Large Marine Ecosystem**

#### **BACKGROUND**

Atlantis (<http://atlantis.cmar.csiro.au/>) was developed at CSIRO (Australia) as an ‘end-to-end’ simulation modeling approach for marine ecosystems that includes oceanographic, chemical (nutrient cycling), ecological (competition and predation), and anthropogenic processes in a three-dimensional, spatially explicit domain (Fulton 2004a,b; Fulton *et al.* 2007, 2011). The simulation approach allows projections through time, and forecasting of system response to specific management actions, physical drivers, or climate change. Atlantis is intended as a strategic management tool to evaluate hypotheses about ecosystem response, to understand cumulative impacts of human activities, and to rank broad categories of management options. It is not intended for tactical decision making, such as precisely setting quotas or siting of marine reserves. Fulton *et al.* (2011) summarize thirteen recent applications of the Atlantis framework, and discuss the appropriate role and strengths and weaknesses of the approach.

#### **OBJECTIVES**

The objective of the methodology review meeting is to:

**Evaluate the performance characteristics and appropriate uses of two Atlantis ecosystem models for the California Current.**

Previous Atlantis models of the California Current have been published in the peer reviewed literature and technical documents (Horne *et al.* 2010; Kaplan *et al.* 2012a,b, 2013). A new version of the Atlantis model is in development, but includes finer resolution of some forage fish and calcifier (shell forming) species, and an expanded geography that matches the full extent of the California Current. Documentation for this new model will be provided to the reviewers.

The review panel will be chaired by a member of the Pacific Fishery Management Council’s Scientific and Statistical Committee (SSC), and the panel will include SSC members as well as Center for Independent Experts (CIE) reviewers. The review will follow the Methodology Review Process established by the Fishery Management Council, and the Terms of Reference below, in part, reflect the Terms of Reference of the Methodology Review Process. The methodology review Terms of Reference will identify the models’ strengths, weaknesses, applicability, and potential areas of improvement with respect to specific management needs on the US West Coast.

The review will not focus on the Atlantis C++ code base, nor will it focus on data quality except as it pertains to model performance.

## **TERMS OF REFERENCE**

All panel reviewers, including CIE reviewers, SSC members, and others, will document the meeting discussions and contribute to a summary panel report that addresses the following terms of reference:

- 1. TOR 1. Reviewers will be asked to consider the strengths, weaknesses, appropriate uses, and potential areas of improvement for the Atlantis models with respect to these management needs, in the context of ecosystem-based management.**
  - a. Food web impacts of groundfish fisheries, pelagic fisheries, and other anthropogenic impacts. Policy example: evaluating trophic impacts of forage fish harvest policies on abundance and yield of other species.
  - b. Ranking of potential fishery management strategies, including spatial management, harvest rates, quota systems. This expands beyond trophic impacts to include habitat, bycatch, and economic indicators. Discussion may differentiate between pelagic vs groundfish fisheries. Potential policy context: Tier 1 Environmental Impact Statements (10 year strategic planning) .
  - c. Evaluation of risks of climate change and ocean acidification. Example: cumulative impacts analysis under National Environmental Policy Act (NEPA), which may consider the impact of actions (e.g. fishing) in the context of global change.
  - d. Informing parameters within single species assessments, e.g. M.
  - e. Formal Management Strategy Evaluation to ‘simulation test’ new methods of stock assessment, data collection, and decision making. Examples: 1) identifying ecological indicators to be tracked by Fishery Council “State of California Current”; 2) evaluating performance of harvest policies that account for spatial impacts of ocean acidification, in context of strategic environmental impact analyses.
- 2. TOR 2. Reviewers will be asked to comment on the technical merits and/or deficiencies of the methodology and recommendations for remedies.**
  - a. What are the data requirements of the methodology?
  - b. What are the situations, management uses, and spatial scales for which the methodology is applicable, if not discussed in TOR 1?
  - c. What are the assumptions of the methodology?
  - d. Is the methodology correct from a technical perspective?
  - e. How robust are results to departures from the assumptions of the methodology?
  - f. Does the methodology provide estimates of uncertainty? How comprehensive are those estimates?

- g. What is the process of model fitting and calibration?
- h. Will the new methodology or data set result in improved stock or ecosystem assessments or management advice, beyond what is discussed in TOR1?
- i. Areas of disagreement regarding panel recommendations: among panel members; and between the panel and proponents.
- j. Unresolved problems and major uncertainties, e.g., any issues that could preclude use of the methodology.
- k. Management, data or fishery issues raised during the panel review.
- l. Prioritized recommendations for future research and data collection.

## CITATIONS

- Fulton, E. (2004a) Biogeochemical marine ecosystem models II: the effect of physiological detail on model performance. *Ecological Modelling* **173**, 371–406.
- Fulton, E. (2004b) Effects of spatial resolution on the performance and interpretation of marine ecosystem models. *Ecological Modelling* **176**, 27–42.
- Fulton, E.A., Link, J.S., Kaplan, I.C., et al. (2011) Lessons in modelling and management of marine ecosystems: the Atlantis experience. *Fish and Fisheries* **12**, 171–188.
- Fulton, E.A., Smith, A.D.M. and Smith, D.C. (2007) Alternative management strategies for southeast Australian Commonwealth Fisheries: stage 2: quantitative management strategy evaluation. *Australian Fisheries Management Authority Report*.
- Horne, P.J., Kaplan, I.C., Marshall, K.N., Levin, P.S., Harvey, C.J., Hermann, A.J. and Fulton, E.A. (2010) Design and Parameterization of a Spatially Explicit Ecosystem Model of the Central California Current. *NOAA Technical Memorandum NMFS-NWFSC-104*, 1–140.
- Kaplan, I.C., Brown, C.J., Fulton, E.A., Gray, I.A., Field, J.C. and Smith, A.D.M. (2013) Impacts of depleting forage species in the California Current. *Environmental Conservation* **40**, 380–393.
- Kaplan, I.C., Gray, I.A. and Levin, P.S. (2012a) Cumulative impacts of fisheries in the California Current. *Fish and Fisheries* **10.1111/j.1467-2979.2012.00484.x**.
- Kaplan, I.C., Horne, P.J. and Levin, P.S. (2012b) Screening California Current Fishery Management Scenarios using the Atlantis End-to-End Ecosystem Model. *Progress In Oceanography* **102**, 5–18.

## Annex 2: Agenda

### Review of the Atlantis Ecosystem Model in Support of Ecosystem-Based Fishery Management in the California Current Large Marine Ecosystem

June 30<sup>th</sup> – July 2<sup>nd</sup>, 2014  
NOAA Northwest Fisheries Science Center  
Auditorium  
2725 Montlake Blvd. E.  
Seattle WA 98112  
Phone: (206) 860-3428

#### **Relevant Terms of Reference (TOR) are noted below.**

#### **Monday, June 30th**

9:00 - 9:10 Call to Order (*Martin Dorn*)

- Introductions
- Approval of Agenda

9:10 - 9:30 Introduction to the role of Atlantis ecosystem model at the Northwest Fisheries Science Center (*Phil Levin*)

9:30 - 9:50 History, goals, and evolution of Atlantis model development at NWFSC and CSIRO (*Isaac Kaplan*)

9:50 - 10:10 Current and potential role of Atlantis ecosystem models for the California Current Integrated Ecosystem Assessment (*Chris Harvey*)

Break

10:30 - 12:00 Overview of mechanics, assumptions, and functional relationships of Atlantis (*Isaac Kaplan*) [TOR2.a-d]

Lunch

1:00 - 2:00 Continued: Overview of mechanics, assumptions, and functional relationships of Atlantis (*Isaac Kaplan*) [TOR2.a-d]

Break

#### CURRENT ATLANTIS MODEL

*Isaac Kaplan*

2:15 - 3:00 Geography and functional groups (*Isaac Kaplan*) [TOR2.a-d]

3:00 - 4:30     Panel discussion (Martin Dorn)

## Tuesday, July 1<sup>st</sup>

9:00 - 11:00 Data (*Isaac Kaplan and Kristin Marshall*) [TOR2.a-d]

- Lower trophic levels
- Fish
- Protected species
- Fisheries and management representation

Break

11:00 - 12:00 Model calibration and fits to history (*Isaac Kaplan*) [TOR2.e-g]

- Estimates of unfished biomass
- Sensitivity to fixed fishing mortalities, estimates of MSY and FMSY
- Fits to historical data
- Sensitivity to initial conditions

Lunch

1:00 - 2:30 Example applications and recent publications (*Isaac Kaplan*)

- a. Food web impacts of forage fish fisheries (e.g. *Kaplan et al. 2013 Environmental Conservation, Marshall et al. submitted*) [ TOR1.a]
- b. Ranking of potential fishery management strategies, including spatial management, harvest rates, quota systems. (e.g. *Kaplan et al. 2012 Progress in Oceanography, Kaplan and Leonard 2012 Marine Policy, Kaplan et al. 2013 ICES Journal of Marine Science\**). [ TOR1.b]
- c. Evaluation of risks of climate change, acidification, and cumulative impacts ( e.g. *Kaplan et al. 2010 Canadian J. Fish. Aquatic Sciences\**, *Kaplan et al. 2013 Fish and Fisheries*) [ TOR1.c]
- d. Informing parameters within single species assessments, e.g. M. (brief discussion of relevant examples from Northeast US) [ TOR1.d]
- e. Simulation testing new methods and metrics for ecological indicators (Testing of spatial indicators within the Integrated Ecosystem Assessment) [ TOR1.e]

*Note the two articles marked with \* use an earlier version of the Atlantis California Current model.*

2:30 - 3:30 Treatment of uncertainty [TOR2.f]

- Bounded scenarios – uncertainty in biomass estimates
- Bounded scenarios – uncertainty in rate parameters

Break

3:30 - 5:00 Panel discussion on potential uses of Atlantis to support Council decision-making identified in TOR 1 (*Martin Dorn*)

**Wednesday, July 2<sup>nd</sup>**

**NEW VERSION OF ATLANTIS MODEL UNDER DEVELOPMENT**

*Isaac Kaplan and Kristin Marshall*

9:00 - 9:30     Goals and applications [TOR 1.a-c,1.e,2.b]

9:30 - 10:00   Geography and functional groups [TOR2.a]

10:30 - 11:00   Data

Break

11:00 - 11:30   Oceanography and global change projections (Al Hermann) [TOR2.a]

11:30 - 12:00   Model calibration and sensitivity tests [TOR2.e-g]

Lunch

1:00-     as needed Panel discussion and writing assignments (Martin Dorn)

### **Annex 3: Format and Contents of Independent Peer Review Report (CIE Reviews)**

1. The independent peer review report shall be prefaced with an Executive Summary providing a concise summary of whether they accept or reject the work that they reviewed, with an explanation of their decision (strengths, weaknesses of the analyses, etc.).
2. The main body of the report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Findings of whether they accept or reject the work that they reviewed, and an explanation of their decisions (strengths, weaknesses of the analyses, etc.) for each ToR, and Conclusions and Recommendations in accordance with the ToRs. For each assessment reviewed, the report should address whether each ToR of the SAW was completed successfully. For each ToR, the Independent Review Report should state why that ToR was or was not completed successfully. To make this determination, the SARC chair and reviewers should consider whether the work provides a scientifically credible basis for developing fishery management advice.
  - a. Reviewers should describe in their own words the review activities completed during the panel review meeting, including a concise summary of whether they accept or reject the work that they reviewed, and explain their decisions (strengths, weaknesses of the analyses, etc.), conclusions, and recommendations.
  - b. Reviewers should discuss their independent views on each ToR even if these were consistent with those of other panelists, and especially where there were divergent views.
  - c. Reviewers should elaborate on any points raised in the SARC Summary Report that they feel might require further clarification.
  - d. Reviewers shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.
  - e. The independent report shall be a stand-alone document for others to understand the proceedings and findings of the meeting, regardless of whether or not others read the SARC Summary Report. The independent report shall be an independent peer review of each ToR, and shall not simply repeat the contents of the summary report.
3. The reviewer report shall include the following appendices:
  - Appendix 1: Bibliography of materials provided for review
  - Appendix 2: A copy of this Statement of Work
  - Appendix 3: Panel Membership or other pertinent information from the panel review meeting.